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[0001] HANDOVER BETWEEN A CELLULAR SYSTEM AND A WIRELESS LOCAL AREA NETWORK

[0002] CROSS REFERENCE TO RELATED APPLICATION(S)

[0003] This application claims priority from U.S. Provisional Application No. 60/399,814, filed July 31, 2002, which is incorporated by reference as if fully set forth.

[0004] FIELD OF INVENTION

[0005] This invention relates to wireless digital communications. More particularly, the invention relates to the interaction and handoff of wireless communications between a cellular network and a localized wireless network with user equipment whose geolocation can be determined.

[0006] BACKGROUND

[0007] Mobile wireless communication has progressed from closed platforms in primarily voice-based cellular phones to becoming embedded in a variety of open platforms which support data and voice, such as smartphones, notebook computers and personal digital assistants (PDAs). Different types of wireless services include WLAN and cellular networks. When a user desires to switch between different services in an unfamiliar geographical area, the available services are difficult to determine. Often, a user must contact the wireless service provider to determine which services are available in particular geographical areas. If the user travels in many different geographic areas, the burden of trying to determine which services are available in which geographic areas becomes too great.

[0008] Accordingly, there exists a need for a user to more easily determine the existence of services in a particular geographic area.

[0009] SUMMARY

[0010] A system facilitates handover of a wireless transmit and receive unit (WTRU) between a cellular network and a wireless local area network (WLAN). The WLAN communicates with a cellular network. A location of the WTRU is determined. The coverage area of the WLAN is determined. The WTRU is informed of the existence of the WLAN when the WTRU approaches the coverage area of the WLAN. The WTRU is handed over from the cellular network to the WLAN when the WTRU is in the coverage area of the WLAN and vice-versa.

[0011] BRIEF DESCRIPTION OF THE DRAWING(S)

[0012] Figure 1 is a general configuration of a wireless communication system in which a wireless mobile unit communicates with a core network for handoff to a WLAN.

[0013] Figure 2 illustrates a scenario where the mobile terminal is being serviced by the cellular network and has the option of using the WLAN.

[0014] Figure 3 illustrates a scenario where the cellular network is no longer available and the mobile terminal is entering an area serviced by the WLAN.

[0015] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0016] The present invention will be described with reference to the drawings figures where like numerals represent like elements throughout.

[0017] The present invention is directed to wireless communication systems with user equipments whose geolocation can be determined More particularly, the invention is a system for hand over between cellular system and a wireless local area network (WLAN) and vice versa of a user based on his/her location. The user equipment can be a cellular mobile phone or a wireless PDA or a WLAN card or various combinations of these, such as a wireless PDA with a WLAN modem. Henceforth, any such user equipment shall be denoted as a wireless transmit receive

unit (WTRU). The location of a WTRU can be determined by one of several established methods. For example, the WTRU can determine its own location using a built in GPS receiver. A second method is the use of network based location methods. In network based location methods, the network determines the location of a WTRU using AOA (angle of arrival) or TDOA (time difference of arrival) techniques and other techniques, by which calculation of the location of the WTRU is performed by the network, either at the base station, Node B or elsewhere on the fixed portions of the network. In the case of a WLAN, the WLAN could provide the calculations. In time distance of TDOA location, a WTRU establishes communications with the network, and the system determines location by knowing the transmit and receive time. The WTRU's signal is received at various antenna sites. Since each antenna is a (usually) different distance from the caller, the signal arrives at a slightly different time. Base station receivers associated with the antenna sites are synchronized by an atomic clock and adjusted for internal signal latency. The base station receivers send the caller's call and timing data on to the mobile switch, where the times are compared and computed to generate a latitude and longitude for the caller. Preferably the signals received by at least three different antennas are processed. The technique requires signal timing information from at least three different antenna sites, but does not require that the WTRUs have internal location equipment. A third method could be a hybrid GPS/network location method, where the network assists the WTRU to determine its own location more efficiently than with a built in independent GPS receiver. This is advantageous because of the limited availability of GPS signals. In any case, it follows that there are several methods available to the WTRU location to be determined. Each method will produce an estimate of the location with an associated margin of estimation error. The location of the WTRU is known to the network and at all times.

[0018] The network that provides the cellular and WLAN coverage also has the geolocations of the coverage area. The geolocation of the coverage are can be calculated by the network by knowing the coverage of the cellular network or WLAN and knowing

the geolocation of the cellular or WLAN transmitter. This way the network can determine the geolocation of the coverage. WTRU is dual mode device capable of accessing the cellular network and WLAN simultaneously. WTRU periodically sends the updated location to the core network.

[0019] If the user with the WTRU having access to the cellular network and wireless LAN, is moving through a cellular network and has reached a point where there is no cellular coverage and there is WLAN coverage or same user is moving through a cellular coverage network which also has a WLAN access, can be informed about the existence of the WLAN coverage through push services. The push service can be any of the application level triggers such as being paged, uses of SMS. This will enable the user to make the decision if he/she wants to switch to WLAN. The decision to switch could be based on many factors such as the cost of WLAN, the speed and through put of WLAN compared to cellular network and requirement of the application currently being used.

[0020] The same techniques can be applied to when the user with the WTRU having access to cellular network and wireless LAN is in WLAN and has the option of switching to cellular network.

[0021] Figure 1 is a general configuration of a wireless communication system which includes a cellular network 10, a core network 11, a mobile unit such as a wireless transmit and receive unit (WTRU) 12, and a WLAN 13. In many cases the cellular network 10 will be an integral part of the core network 11 and the WLAN 13 will sometimes also be an integral part of the core network 11. The WTRU 12 communicates with a core network 11 via a cellular radio access network (RAN) 10 for handoff to a WLAN 13. The core network 10 could be any network (like IS-41 core network, GPRS IP core network, or Evolved GSM core network) that connects to a cellular radio access network (RAN) (such as GSM RAN, IS-95 RAN, CDMA RAN or WCDMA RAN). The WTRU 12 is capable of communicating with either the cellular radio access network (RAN) 10 or various local networks, such as WLAN 13.

[0022] The core network 11 includes a WLAN service location database 23 and a position comparison device 24. A location device 26 permits the core network 11 to determine the location of the WTRUs 12.

[0023] The WTRUs 12 each include a cellular network communication device 32, a WLAN communication device 33, and a handoff device 34. Optionally some or all of the WTRUs 12 may have a GPS receiver 35. The location determination may be performed by the cellular 10 or core 11 network, using location information available at the networks, or by the WTRU 12, such as by using the GPS receiver 35. The location of a WTRU 12 can be determined by using a built in GPS receiver, using AOA (angle of arrival), TDOA (time difference of arrival) techniques, a hybrid GPS/network location method, or any other convenient method. In addition, a cellular service location database 27 is provided, which includes coverage location information of cellular service other than WLAN 13 coverage. The WLAN service location database 23 and cellular service location database 27 are matched to the location information by the position comparison device 24. The use of the databases enables the information in the databases 23, 27 to be used when the mobile can do a handoff from WLAN to cellular network. This allows information concerning the availability of the cellular network to be pushed through the WLAN 13.

[0024] If a particular WTRU 12 determines the location, the location is sent to the core network 11, such as by signaling the information. The WLAN service location database 23 includes information concerning the geographical locations of WLANs, such as WLAN 13. The WLAN 13 communicates with the core network 11 and can update/modify the contents of the WLAN service location database 23. The WTRU 12 includes a cellular network communication device 32, a WLAN communication device 33 and a handoff device 34 to facilitate a handoff between the core network 11 and the WLAN 13. The position comparison device 24 finds WLANs servicing the determined position of the WTRUs 12 using the WLAN service location database 23.

[0025] In operation, the core network 11 communicates with the WTRU 12 through base stations of the cellular radio access network (RAN) 10, such as base

station 25. As part of the communication function, the core network 11 can provide handoff information, which indicates the availability of a WLAN 13 based on the WTRU's location.

[0026] In one configuration, the WTRU 12 provides positioning data from the GPS receiver 35 to the core network 11. This positioning data indicates the location of the WTRU 12. This information is provided to a position comparison device 24, which compares the position of the WTRU 12 to known servicing areas of local wireless networks, such as WLAN 13, and the base stations 25 of the core network 11. The WLAN service location database 23 provides mapping data concerning the radio coverage areas of these local wireless networks.

[0027] Further information, such as pricing, speed, service availability and available coverage of the WLANs may also be provided to the WTRU 12. Effectively, this information is provided by push communication to the user, as indicated by push services device 36. "Push communication" is intended to describe the provision of information, referred to as "push" services, without the user specifically requesting the information at that time. To illustrate, the network 11 identifies a WLAN 13 in a WTRU's vicinity. The network 11 sends the WTRU 12 pricing and speed information of the WLAN 13. A user of the WTRU 12 can determine whether utilizing the WLAN 13 is desired, based on its cost and speed. The user selection can be predetermined, or can be elected "on the fly" upon notification of the availability of the WLAN services. In the case of predetermining whether to accept a handoff, the user can preprogram handoff information, as indicated at block 37, which would store user pre-selection criteria in memory 38

[0028] Likewise, there may be instances in which the user may wish to terminate communications or terminate particular types of communications when leaving the coverage area of the WLAN. Examples would be the use of free or low cost services such as high bandwidth data transfers, or the provision of local voice communication services. Therefore, the WLAN 13 is preferably able to notify the WTRU when WLAN

service is to be discontinued, or a handoff to the core network 11 is available. Preferably, the user can decline to continue service after the handoff to the core network 11, and it is also preferable that the user can make the determination whether to accept the handoff prior to the handoff.

[0029] The core network 11 additionally can provide information to the WLAN 13 to facilitate handover, such as information indicating that the WTRU 12 may be able to receive signals from the WLAN 13. After handover, the WLAN 13 may also provide "push" services. These services may be provided on a continuous basis. Such information may include shopping information, or information concerning directions in the WLAN 13. The mobile user can select to receive this information. To illustrate, the user can turn on a WLAN feature, the WTRU 12 is able to receive WLAN information without otherwise requesting it. The provision of the WLAN service location database 23 and the cellular service location database 27 provides for information about the availability of a handoff between the WLAN and cellular service. The database information can also be provided to the WTRU 12 by "push" delivery to the WTRU through either the WLAN or the cellular network.

[0030] It is possible for the WTRU 12 to provide location information to WLAN 13 when WTRU 12 is serviced by WLAN 13. Whenever WTRU 12 provides the location information to WLAN 13 or WLAN 13 determines the location of WTRU 12, the WTRU 12 location information is updated in the core network 11 by WLAN 13. This information is used by the position comparison device 24 in the core network 11 for handoff from WLAN to the cellular network if required.

[0031] Referring to Figure 2, a WTRU 12 is shown traversing a cellular network 10. The WTRU's position is tracked. The WLAN boundary 62 is either known a priori by the network 11 or is provided by the WLAN 13. Accordingly, the core network 11 knows the current location or approximate location of the WTRU 12 and also the coverage area 62 of the WLAN 13. As can be seen, information from the WTRU 12 is provided to the core network 11 in which the WTRU 12 periodically updates the core

network 11 about the location of the WTRU 12. Also as can be seen, the WLAN 13 provides information to the core network 11. This information may include information of the coverage area of the WLAN 13 and of services offered by the WLAN 13. The core network, 11 provides information to the WTRU 12 about the existence of the WLAN 13 network. This information from the core network to the WTRU 12 may be "push" information.

[0032] As the WTRU 12 moves through a geographic region serviced by the WLAN 13, the cellular network 11 serving the WTRU 12 informs the WTRU 12 of the existence of the WLAN 13, such as by using the "push" services, of the cellular network 11. The user can then chose to switch the network from the cellular network 11 to the WLAN 13. Other information as to the costs, choice of networks and other network features can also be sent as part of the "push" services.

[0033] In another scenario as shown in Figure 3, this switch between networks may be made automatically. In Figure 3, the cellular RAN 10 is no longer available in the geographic area the WTRU 12 is moving towards.

[0034] As can be seen, information from the WTRU 12 is provided to the core network 11 in which the WTRU 12 periodically updates the core network 11 about the location of the WTRU 12. Also, as can be seen, the WLAN 13 provides information to the core network 11. This information may include information of the coverage area of the WLAN 13 and of services offered by the WLAN 13 and information to the WTRU 12 about the existence of the WLAN 13 network. This information from the core network to the WTRU 12 may be "push" information. As shown in Figure 2, the cellular RAN 10 has a coverage region 61. The WLAN 13 has a coverage region 62, which is partially outside of the core network coverage region 61. If the core network 11 determines that the position of the WTRU 12 is within the WLAN region 62, the core network 11 is able to inform the WTRU 12 of the availability of WLAN services. When the WTRU 12 exits the geographical coverage 61 of the core network 11, the WTRU 12 is provided with handoff information identifying the WLAN 13 associated with the

WLAN region 61, to the WTRU 12. In this scenario, the handover to the WLAN 13 may be made without the knowledge of the mobile user. Alternately, the mobile user may be prompted through the "push" services to decide whether the current wireless service is to be dropped or supported by the WLAN 13, potentially at an additional cost. If the WTRU is GPS enabled or otherwise is provided with location information, the WTRU can directly determine whether to initiate execution of a handover.

[0035] One advantage of using "push" services is that at an application level the user can chose to switch the networks. The information about the costs and the speed of the new service can be provided as part of the information being pushed to the user. These costs can vary and depend upon the number of users in the service provider's network and other criteria. The "push" services allow the user to have the latest information available at all times.

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